

**Some Factors Affecting the Seasonal Prevalence of Internal
Parasites in A Semi-intensive Dairy Production System in
Omdurman Locality, Sudan**

By

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((لَا يُكَلِّفُ اللَّهُ نَفْسًا إِلَّا وُسْعَهَا لَهَا
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عَلَى الْقَوْمِ الْكَافِرِينَ))

صدق الله العظيم

DEDICATION

TO

MY FAMILY

WITH LOVE AND RESPECT

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خلاصة الأطروحة

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Abstract

This study was conducted in the dairy cattle of Al-Rodwan dairy project in Omdurman town during the three different seasons of the year (Dry cool, dry hot, wet hot season) to investigate the prevalence of internal parasites and to assess the relationship between the occurrence of internal parasites and other factors such as seasonal variations, milk yield, packed cell volume, breed, age, and sex.

290 faecal samples were collected randomly from the dairy cattle and examined in the laboratory using the microscope.

The results of the faecal examination showed that the prevalence of the internal parasites during the three different seasons of the year was 16%, 8.42%, and 7.36% for dry cool, dry hot, and wet hot season respectively. The prevalence of *Coccidia species* infection was found to be 13%, 4.21%, and 2.10% for dry cool, dry hot, and wet hot season respectively, while the prevalence of *Fasciola species* infection was 1%, 4.21%, and 4.21% for dry cool, dry hot, and wet hot season respectively. The prevalence of *paramphistomum species* was only recorded during the dry cool and wet hot seasons given percentages of 2% and 1.05% respectively.

The results also revealed that no nematode parasites were encountered during the three different seasons of the year.

The results of the study revealed that there was no influence of season on the prevalence of internal parasites during the three different seasons of the year. The results also revealed strong association between the age, sex, and breed of the animal and presence of internal parasites. It also revealed a positive correlation between the milk yield and the occurrence of internal parasites, in contrast, it revealed a negative correlation between the Packed Cell Volume and presence of the internal parasites.

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Chapter one

1-1 Introduction

Sudan is the largest African and Arab country occupying an area estimated to be one million square milles, with a great variation in climatic conditions including rainfall, temperature, relative humidity and wind direction, in addition the variation is also in vegetation, soil types and ecozones. The country is also endowed with diverse agricultural activities which are determined by climate and animal resources and human population density. More than 90% of livestock in the country is owned by nomadic and semi-nomadic tribes, with a regular system of seasonal migration mostly from North to South and vice versa. The animal population distribution in Sudan generally follows the diversity of rainfall and vegetation, with the exception of highly developed agricultural regions such as the Gezira area and schemes along the White and Blue Niles banks.

Among cattle population in Sudan are two important breeds, Kenana and Butana which show considerable milk potentialities, but they are relatively few in number as compared to the other cattle types in the country. Consequently it is high time that the main gene pool of those superior breeds be conserved from being diluted through unplanned crossing with exotic breeds. Kenana cattle homeland is located at a triangular area bounded by Sennar, Singa, Roseries and Kosti, while Butana cattle are found in the Butana plain between the Nile, Blue Nile and Atbara rivers.

Recently, the demands for liquid milk have increased with the rise in human population, therefore, improvements of dairy cattle have become of paramount importance. Several trials for improvements have

been attempted in the tropical countries with limited results due to many constraints these are:

Firstly, the nomadism, which is the main type of cattle management and husbandry practices. 80% of animal population lead nomadic and semi-nomadic life and the remaining 20% is reared in irrigated areas and private farms. Sudan is engaged at present in the development of dairy industry in irrigated areas by upgrading native stock with high producing foreign breeds, that necessitate the importance of good management and control of dairy farms diseases for successful dairy industry. The nomads drive their herds for long distances in search of grass and water. The herds congregate in good grazing areas and at water points. This nomadic way of animal husbandry has its implications upon epidemiology of parasitic diseases. The herds become infected with gastrointestinal helminthes, protozoans, and external parasites.

Secondly, the relatively poor potentiality of the local dairy cattle, Butana and Kenana and the higher demand for milk consumption in the urban centers necessitate the use of cross-breeding for improving the productivity of indigenous dairy cow. Cross-breeding was first introduced in 1925 when a shorthorn bull was mated with indigenous Butana cows in a farm near Khartoum. Since then different exotic breeds were introduced with friesian being the dominant. This was largely supported by artificial insemination services. Consequently milk production was improved with increased foreign blood.

Thirdly, the management which includes, general aspects of practices, environmental control, housing, health care, lactation and fertility management. A farmer has to provide a safe environment and attention must be paid for cleanliness and hygiene around the farm, removal of pollutant, drainage, waste disposal, removal of dung and soiled bedding and maintenance of clean milking utensils. Regular husbandry routines

should be maintained that animals are not subjected to unpredictable and unsettling change.

Fourthly, the prevalence of pathogen -caused diseases. Bacterial and viral disease have almost been brought under control either by drug therapy or vaccination. Parasitic diseases, however, have largely been neglected primarily because they do not often cause acute fatal diseases.

Consulting available literature of Sudan veterinary services no records was encountered dealing with parasitic infestations in dairy cattle in the different seasons of the year in Khartoum State. The objectives of this study were :

- 1- To determine the presence of internal parasites in the dairy cattle in a semi intensive system at Al-Rodwan Dairy project.
- 2- To determine the subclinical changes that may result from such internal parasitic infestation using PCV and milk production as indicators .
- 3- To assess the environmental and climatic factors that may affect the internal parasitic infections intensity.

1-2 Review of Literature

1-2-1 Internal parasites of dairy cattle

Internal parasites other than those inhibiting the circulatory system are wide spread in dairy cattle and include protozoan, platyhelminth and nemathelminth parasites (Chen, 1973).

1-2-1-1 Protozoan parasites

These are single celled, many have flagella, or cilia, or pseudopods that enable them to move round. The main divisions of protozoa according to Levine (1973), are;

1-2-1-1-1 Pseudopodians

These move by extension of their protoplasm, through flexible body morphology, to form pseudopods (false feet). They can be free-living or parasites, e.g. *Entamoebae species.*, *Amoebae species.*

1-2-1-1-2 Flagellates

These move by means of, single or multiple flagellae, members of this group are classified based on the location of their flagella and the number of flagella they have into blood flagellates e.g *Trypanosoma species*, tissue flagellates e.g *Leshimania species*, intestinal flagellates e.g *Giardia species.*, and vaginal flagellates e.g *Trichomonas vaginalis*.

1-2-1-1-3 Ciliates

These move by means of cilia, e.g. *Balantidium Coli* (an enteric organism found in the gastrointestinal tract).

1-2-1-1-4 Sporozoans

These have no visible means of locomotion, have no flagella, cilia, or pseudopoda. They move using the host's cells, e.g. *Eimeria species*.

1-2-1-2 Platyhelminth parasites

These are classified according to Yamaguti (1963), into;

1-2-1-2-1 Cestodes (tapeworms)

These are flattened dorsoventrally , have no digestive system, and are hermaphrodites, unlike the flukes, the adult stages are only enteric (found mostly in the gastrointestinal tract) and the intermediate stages are however , found in different parts of the body e.g., *Echinococcus species*.

1-2-1-2-2 Trematodes (Flukes)

These are flat worm with an incomplete digestive system and a hermaphrodite reproductive system. The intermediate hosts being predominantly snails. They are classified based on their location into intestinal flukes, liver flukes, rumen flukes, lung flukes and blood flukes.

1-2-1-3 Nematelminths

These include the round worms (nematodes) which are the most sophisticated worms, they have a cylindrical body shape, with a fairly developed digestive system. They have separate sexes with a direct or indirect life cycles where intermediate hosts, mostly arthropods, are involved Anderson *et al* (1974).

1-2-2 Life cycle patterns of internal parasites

Knowledge of the life cycle and characteristics of parasitic worms is essential for their control. The direct life cycle is common to most parasites, however some parasites have an indirect life cycle, which involves an intermediate host ranging from Arthropods, moluscus and mammals.

1-2-2-1 The general life cycle of nematodes

Various life cycles are found among nematodes depending to some extent on the degree of adaptation to parasitic existence that has been reached. The most specialized species e.g. *Trichinella species* have no period of free existence at all, the life cycles may, therefore, be classified as follows:

1- Without an intermediate host

1. Eggs hatch outside the host and larvae are free living for a time, infective larvae are active e.g. *Strongylidae* and *Trichostrongylidae*. Entry into the host is through the mouth with food and water, but the infective larvae of some species can penetrate the host skin as well as entering through its mouth (*Ancylostoma species.*, *Bunostomum species*)
2. Eggs develop outside the host but do not hatch there , infective larvae are passive inside the egg . Entry into the host occurs only through the mouth e.g. *Ascaridae*

2- With an intermediate host

1. Eggs hatch or the worms are *viviparous* and the larvae enter the intermediate host after a short free existence e.g. *Habronema species*. The intermediate host is eaten by the definitive host.
2. Eggs do not hatch and are ingested by the intermediate host e.g. *Spiruroidea*. Intermediate host is eaten by the definitive host.
3. The worms are *viviparous* and the larvae enter the blood of the host from which they are taken up by a blood-sucking intermediate host, inside which the infective larva develop. When the intermediate host sucks the blood of the definitive host, the infective larvae break out of proboscis of the intermediate host and penetrate into the definitive host through its skin e.g. *Filarioidea species*. After having entered the final host many nematodes

migrate through the body before settling down to their normal habitat and some of them do much harm in a mechanical way during this process (Soulsby 1982).

1-2-2-2 The General life cycle of trematodes

Eggs of adult trematodes are usually passed in the faeces of the host and under suitable conditions of moisture and warmth, these eggs hatch releasing free living miracidia. Five larval stages may occur in the life cycle, miracidium, sporocyst, redia, cercaria and metacercaria, but daughter sporocysts and rediae may also occur. Mesocercariae, prolonged cercarial stages, may occasionally occur e.g. *Alaria species*.

A miracidium enters the intermediate host (snail). Following penetration, the ciliated coat of the miracidium is lost and the form becomes a sporocyst—an undifferentiated mass of cells. Within the sporocyst the germinal cells multiply and produce either daughter sporocysts or rediae, although rediae are not always a feature of all digenetic trematodes and do not occur in the life cycle if daughter sporocysts are formed. One or more generations of rediae may occur. The final stage, the cercaria, is produced by the sporocyst or the redia. Cercariae usually encyst on vegetation or in a second intermediate host. The encysted form undergoes physiological maturation to produce the infective stage, the metacercaria. The metacercaria may enter the definitive host passively on contaminated herbage or in water or in a second intermediate host. However, in the family *Schistosomatidae*, cercariae actively penetrate the skin of the definitive host. Following ingestion, metacercariae invade the wall of the gastrointestinal tract and migrate to the liver. During migration they continue to develop into mature flukes. Upon reaching the liver they invade and continue their migration through the liver tissue and eventually enter the bile ducts

where they develop to adults, feed on bile and begin to lay eggs (soulsby 1982).

1-2-2-2-1 Reservoir hosts of liver flukes

Cattle

Most authors agree that cattle are relatively more resistant to liver flukes than sheep (Dixon, 1964; Ross, 1966, 1967; Boray, 1967; Sinclair, 1967) and hence, individual variation of host reaction is greater in them (Boray, 1969). Yet, cattle seem to be the main reservoir of fascioliasis in Africa (Dinnik and Dinnik, 1959). *F. hepatica* is less infective but more pathogenic to cattle than *F. gigantica* and this suggests that bovines are the natural hosts of the latter.

Wild life

Hammond (1973) surveyed fascioliasis in African wild life and reported that the disease is not very prevalent except for *F. nyanzi* in the hippopotamus; the giraffe, however, seems as it can harbour the parasite for several years. This worker found only few reports of *F. hepatica* in wild animals, but according to Dinnik and Dinnik (1959), antelopes, buffaloes, giraffes, and other wild species may act as reservoir hosts of liver flukes.

1-2-2-3 The General life cycle of cestodes

Like the liver fluke, the tapeworm requires an intermediate host to complete its life cycle. Free-living mites feed on the egg-bearing segments of the adult tapeworm that are passed in manure. Tapeworm infection develops when infective mites are eaten during grazing. Adult tapeworms attach themselves to the mucosal wall of the small intestine. Tapeworms grow in segments as they absorb nutrients from ingesta in the

small intestine. Infections in older cattle are usually of minimal consequence (Pawlowski *et al*, 1972).

1-2-2-4 The general life cycle of *Eimeria* species

The oocyst, which contains the zygote, is extruded from the host tissues and passed to the exterior in the faeces .This is the resistant stage of the life cycle, and under appropriate conditions it forms the mature infective oocyst. In the sporulated oocyst there are four sporocysts. Each sporocyst contains two sporozoites. The parasitic life cycle of *Eimeria* species is initiated when the infective oocyst is ingested by the appropriate host. Excystation releases the contained sporozoites, two separate stimuli are necessary for Excystation. The first is provided by CO₂ and the second by trypsin and bile. Bile facilitate the entry of trypsin through the altered micropyle , which then digests the sporocystic plug permitting escape of the motile sporozoites. Liberate sporozoites are transparent and show rapid gliding movements. The penetration into the host cells is quick and completed within few seconds.

Asexual reproduction or schizogony

This process is initiated when the sporozoites enter the epithelial celles and become rounded up. The development occurs inside the nucleus, the rounded up sporozoite is, at this stage, known as trophozoite, and within a few days the nucleus of the trophozoite divides by schizogony to become a schizont - the first generations of schizogony. The nuclear division in schizogony is considered to be of the mitotic type. Initially the cytoplasm is undivided, later the daughter nuclei are each surrounded by a clear zone of cytoplasm, and eventually number of elongate fusiform organisms are produced : the first generation merozoites. The number of merozoites which are formed in the first generation schizont vary according to species. In *Eimeria bovis* more than

100.000 first generation merozoites may occur. When the schizont is mature the first generation merozoites are released and they then enter other epithelial cells in the area and continue the cycle of asexual development . The second generation may proceed to a third or more generations of asexual reproduction, or they may differentiate into sexual or gametogenous forms.

Sexual reproduction or gametogony

The factors responsible for initiation of gametogenous cycle are not fully understood . Although generally considered to be genetically determined, host responses may play a role, through phenotypic determination, in terminating schizogony. In general, the number of microgametes (male forms) greatly exceeds the macrogametes (female forms), the former begin very much smaller than the later. Fertilization by the microgametes may occur at any point on the surface of the macrogamete : a zygote is formed and the oocyst wall is laid down around it. When the cyst wall is completed the oocyst is extruded from the tissues and passed to the exterior.

Sporogony

Sporulation does not occur until the oocyst is shed to the exterior of the body. Initially, the zygote almost fills the oocyst cavity, but within a few hours outside the host the protoplasm contracts from the wall of the oocyst to form a sporont and leaves a clear space between it and the wall. The sporont divides into four sporoblasts, these sporoblasts later become sporocysts by the laying down of a wall of retractile material around each sporoblast. The protoplasm inside each sporocyst further divides to form two sporozoites. Oxygen and adequate moisture are necessary for the sporulation, and at constant temperatures, an increasing percentage of oocysts are killed as relative humidity decreases.

Temperature also has an important influence on sporulation. The optimum temperature for sporulation is about $30^{\circ}C$. In general, sporulated oocysts are more resistant to dessication and cold and many survive for up to two weeks at temperatures of $-12^{\circ}C$ to $20^{\circ}C$. Unsporulated forms are killed in 96 hours at these temperatures. Factors such as soil types, exposure to direct sun light, the amount of humus in soil, and moisture are important in the longevity of oocysts (Soulsby, 1982).

1-2-2-4-1 Bovine coccidiosis

Is a major parasitic disease problem in dairy industry caused by a protozoan parasite. It has been estimated that there are at least 12 different species found in cattle, but only two of them are believed to cause the disease, these are *Eimeria bovis* and *Emeria zuernii*. The disease mainly causes problems in young animals, but it has also been diagnosed in growing replacement heifers, pregnant heifers and in cows following parturition. The disease is characterized by bloody diarrhea and anaemia.

Calves 3 weeks to 6 months old are most susceptible to infection. The disease usually strikes at weaning time when calves are moved to overcrowded, dirty and wet pens. Feeding hay from the ground or grain from low troughs which are easily contaminated by faecal materials increases the likelihood of infection (Herrick *et al* 1990).

1-2-3 Prevalence of some internal parasites in dairy cattle

1-2-3-1 Prevalence in Africa

1-2-3-1-1 prevalence of gastrointestinal nematodes

Gastrointestinal nematodes are prevalent in almost all parts of the world, their distribution however, differ from one part to the other. There

exists a formidable list of roundworms affecting domestic animals in the tropics, the majority of which also occur in more temperate zones but which, in a tropical environment, find conditions ideal for their development at all stages of their reproductive cycle. Amongst the studies conducted in Africa were those conducted by Puglisi *et al* (1989) in Central Africa Republic who showed that there was an infection rate of 69% in cattle and 79% in calves. They found high proportion of mixed *Strongyloides papillosus*, *Ascarid* and coccidial Infection. In Gambia Kaufmann and Pfister (1990) detected *Haemonchus contortus* (67%), *Cooperia punctata* (75%), *C. pectinata* (55%), *Oesophagostomum radiatum* (7%) and *Bunostomum phlebotomum* (21%). Gahutu (1988) made a comparison between the prevalence of gastrointestinal nematodes in wet and dry seasons in cattle in Rwanda, he showed that the prevalence of nematodes in dry season was 70.7% and in the wet season was 76%. The list of parasites encountered in the study revealed: 57.7% *H. placei* 46.5% *O. radiatum* 31% *T. axei* and 23% *C. punctata*. Similar study conducted by Horchner *et al* (1981) in Burundi showed that the prevalence of *Strongylidae*, *Trichostrongylidae*, and *Strongyloides* in calves was higher during the rainy season and the end of the dry season. In Central Kenya, a study done on the epidemiology of gastrointestinal nematodes of dairy cattle (Waruiru *et al.*, 2001) showed that *Haemonchus placei*, *Trichostrongylus axei*, *Cooperia species*, and *Oesolophagostomum radiatum* were responsible for parasitic gastroenteritis and *Haemonchus placei* was the predominant nematode present in the young cattle. The study also revealed that the total worm burdens in animals were highest during the rainy season and lowest during the dry season. Another study in Central Kenya on the prevalence and intensity of helminths and coccidial infections in dairy cattle was conducted by the same investigators (2000). In this study the effect of age, sex, farm and season

were detailed. The results of this study revealed that the most prevalent nematode genera were *Haemonchus*, *Cooperia*, *Oesophagostomum* and *Triostongylus*. Season, farm and age of the animals had a significant influence on the intensity of infection with strongyles, liver flukes and *coccidia*, whereas the sex of the animals had no significant effect on the prevalence or intensity of infections. The study showed also that a higher intensity of infection with strongyles and *coccidia* was found in the wet season than in the dry season. The study also showed that age-specific intensity was in the following orders for strongyles, immature animals of 6-12 months of age had the highest egg counts, followed by young calves and adults. The study also revealed that calves had significantly higher oocyst counts than immatures or adults. Liver flukes counts did not differ significantly between immatures and adult cattle.

1-2-3-1-2 Prevalence of trematodes

Fasciola gigantica

Common liver flukes of domestic stock in Africa, it occurs frequently in Asia, the Pacific islands such as Hawaii, the Philippines, Southern USA, Southern European, Russia and the Middle East.

In Nigeria, Schillhorn van Veen *et al* (1980) found the prevalence of *F. gigantica* in cattle, sheep, and goats was 65.4, 40.8 and 17.6 respectively. They observed that the faecal output was highest during and directly after the rainy season and lowest at the end of the dry season. The prevalence was highest at the beginning of the dry season.

In Nigeria, Ogunrinade *et al* (1981) reported that the prevalence of *F. gigantica* in about 1-2 million cattle slaughtered at 12 major abattoirs in various climatic zones was 2.5%. The highest prevalence was found in Northern Guinea savannah (5.66%) and the lowest in Jos Plateau

(0.88%). The prevalence was also highest during July to October in the savannah.

Telmbely *et al* (1988) studied the prevalence of *F. gigantica* in Mali and showed an infection rate of 50% in zebu cattle in Sahelian region, 7% in zebu cattle in subdistrict region and 12% in N' Dama and zebu X N' Dama in the Sudanese region. Traore (1989) mentioned that faecal samples of 500 cattle in 6 villages around Niono Mali were examined, and he showed that liver flukes infection rate in the dry season was 18% while in the rainy season it was 10.9%. In Tanzania, a longitudinal descriptive study was done on the epidemiology of *Fasciola gigantica* and *Amphistomes* in cattle on traditional, small scale dairy and large scale dairy farms (Keyyu, *et al.*, 2005). This study showed that the prevalence of flukes was highest in the traditional system, moderate in the large-scale dairy system and lowest in the small-scale dairy system in most parts of the year. The study also revealed that adults and yearlings had the highest prevalence of flukes in all management systems throughout the year. This study showed that the proportion of animals passing fluke eggs increased gradually from the early dry season and peaked at the end of the dry season and the early part of the rainy season.

Schistosoma bovis

S. bovis occurs in the portal and mesenteric veins of cattle, sheep, and goats in Central, East and West Africa, the Mediterranean area and in the Middle East (Soulsby, 1982). In Africa *S. bovis* and *S. mattheei* are widely distributed and both are thought to cause significant economic losses.

Prevalence in Africa may be as high as 90%, and appears to be increasing in cattle, but varies considerably from one region to another (Lossos, 1986). The distribution of species causing bovine schistosomiasis had been published by Christensen *et al* (1983).

Surveys in Zimbabwe showed 50 to 70% infection rates in cattle and sheep (Lawrence and Condry, 1970). The incidence of *S. bovis* in some regions of Nigeria was relatively low during drought conditions and was dependent on the establishing of water reservoirs (Pough *et al.*, 1980). Reports had been made on the occurrence of *S. bovis* from other countries including the Congo (Schwetz 1955) and Ethiopia (Lo and Lemma, 1975).

1-2-3-1-3 Prevalence of cestodes

Cysticercus bovis

Cattle serve as the principal intermediate host of the tapeworm *T. saginata*. Grass and water contaminated with eggs when ingested by cattle develop the larval stage (*C. bovis*). The occurrence of the adult tapeworm in man and the larval stage in cattle is reported from most parts of the world. It is significantly high in places where health and sanitary conditions are far from ideal and where the habit of eating raw or not-well cooked beef is practiced.

Hydatid cysts

Hydatid cysts, the larval stages of the dog tapeworm, *Echinococcus granulosus*, develop in most species of domestic animals. The disease is cosmopolitan in distribution.

1-2-3-1-4 Prevalence of coccidiosis

In Tanzania study conducted on eimeriosis in dairy cattle farms (Chibunda, *et al.*, 1997) revealed that the oocyst output was high in calves, followed by weaners; adults had the lowest oocyst output. The number of oocysts per gram of faeces was significantly higher in diarrhoeic animals than in non-diarrhoeic animals, and more so in young calves. The highest prevalence was observed in animals aged between

5 and 18 months, whereas lower prevalence were observed in calves aged between 12 days and 4 months and adults. No coccidial oocysts were detected in calves less than 12 days old.

1-2-3-2 Prevalence in Sudan

1-2-3-2-1 infections with gastrointestinal nematodes

Abdel Malek (1959) made some valuable contributions and added to our knowledge about the occurrence of some helminths of cattle in Sudan. Eisa (1963) investigated the incidence of helminth parasites in cattle in Upper Nile Province. He found that the total "strongyle" egg-per-gram counts never exceeded 85. The maximum was reached in May and the counts fluctuated considerably during other months. He showed that *Haemonchus contortus* was the principal species of round worms encountered in his survey. The incidence of infection was 32%. Worms collected from individual animals however, varied between 2 and 98 adult parasites. Immature stages were never seen. He stated that, considering the prolific nature of the female *Haemonchus contortus* which produces 5000 to 10,000 eggs every day, it was rather surprising not to find the parasite in great numbers and associated with clinical parasitism. In explaining this dilemma, Eisa (1966) believed that the continuous and wise use of phenothiazine had reduced contamination of the pasture which resulted in protection of young animals from heavy infestations early in their lives.

This study was followed by a similar one made by EI-Khawad *et al* (1976) who observed no eggs indicating the presence of nematodes in cattle, sheep and goats in Equatoria, Bahr EL-Ghazal and Upper Nile.

1-2-3-2-2 Infections with trematodes

Fasciola gigantica was first observed in 1914 in cattle in Malakal (Eisa, *et al.*, 1979). Abdel-Malek (1959) reported the parasite from bile ducts of cattle in Wau, Rombek, Sennar, Kosti, Fashir & Nyala. However, the first serious effort to discuss fascioliasis in cattle in Sudan was published by Karib (1962). He stated that *F. gigantica* predominated in the area along the White Nile which lay between Dueim & Malakal and which is about 300 miles long. Ahmed (1990) stated that the reasons for the high incidence of fascioliasis in the areas of the White Nile or its tributaries appeared to be due to the following :

- The presence of *Lymnea natalensis* snail, the intermediate host of *F. gigantica*, in large numbers in the flood plains of the White Nile River. The optimum environmental conditions such as the slow flowing water and the presence of abundant aquatic plants especially the water hyacinth facilitates the growth and survival of the snails.
- The horizontal expansion in cultivated areas of both irrigation schemes and shifting agriculture had reduced the amount of pasture for both nomadic and settled herds which resulted in driving the livestock to graze the swampy areas of the flood plains which harbour the infected snails during the dry season.

Karib (1962) indicated the incidence of the disease throughout the country, of which, the high percentage incidence of 26% was obtained for cattle in Upper Nile Province. Eisa and Dalil (1963) showed that the incidence of *F. glgantica* averaged 19.5% in bovine livers in Malakal area. Eisa (1963) showed that 37% of the cattle in Upper Nile Province were infected with *F. gigantica*. He stated that immature stages of *F. gigantica* were first seen in February, but the infection was judged to be acquired two to three months earlier i.e in early November. The incidence

reached a peak in June while the highest degree of infection, that is the highest number of parasites per host, was found in July. Karib (1962) suggested that the time of treatment for liver flukes in the enzootic area of the White Nile falls between November and January or February when the cattle are driven to their summer-river-grazing. He stated that they are usually dosed again in May when driven away at the onset of rains. Eisa (1963) suggested that cattle of Upper Nile Province should also be dosed in April and again in July. El- Khawad *et al.*, (1976) reported the incidence of infection in Equatoria to be 33.3%, Bahr EI-Ghazal 55.7%, and Upper Nile 47.2%. All these investigations indicated that fascioliasis was quite common in the southern parts of Sudan. Unfortunately, there are no recent studies that reflect the present situation of the disease in the south. In western Sudan, EI-Khawad *et al* (1978) reported that the infection rate in Baggara cattle reached 10%.

Schistosoma bovis was first reported in 1915 in the White Nile Province Eisa *et al.*, (1979). Eisa (1963) showed that the incidence in cattle in the Upper Nile Province was 30% in April, and 80% in June, with an average of 49.5%. The incidence of *S. bovis* encountered in bovine in Malakal area was 56.6% (Eisa and Dalil, 1963). EI-Khawad *et al.*, (1976) showed the percentage of infection of cattle in Equatoria, Bahr EI-Ghazal and Upper Nile were 53.4%, 61.9% and 47% respectively. Two years later, the same investigator and his colleagues revealed very high incidence of *S. bovis* in cattle in western Sudan reaching 89.7%.

Hussein *et al.*, (1981) conducted a survey that determined the degree of infection of cattle with schistosomiasis in Kosti area. They reported that about 90% of the calves under 2 years of age were infected. The infection was found to decrease with increasing age. It reached 30% in cattle which were 10 years old and over. In 1974 multifunctional project was erected to investigate the prevalence and epidemiology of

schistosomiasis in cattle in the Sudan and possibly to protect animals using irradiated vaccine. Calves were immunized against *S. bovis* using irradiated cercariae or schistosomula (Bushara *et al.*, 1978). Taylor (1980) stated that irradiated *schistosomula mattheei* and *S. bovis* when given subcutaneously or intramuscularly to cattle or sheep, induced a greater than 60% level of protection against infection. Of particular importance is the economic advantage that can be attained through immunization against experimental and field infections. Immunized calves had significantly higher growth rates, superior body composition, decreased faecal and tissue egg counts and lower adult worm counts. In addition, immunized calves showed milder histopathological and haematological changes than did unimmunized calves.

Paramphistomiasis is caused by several species of rumen flukes which infect cattle. Infections with the adult flukes do not seriously affect the animals. However, the disease is caused by immature worms while still in the intestine before migration to the stomach. When present in large numbers in the intestine, the young immature paramphistomes, are pathogenic. Infections with paramphistomiasis is acquired from the same habitats where the animals also contact fascioliasis and bovine schistosomiasis where various species occur together. In various countries, outbreak of paramphistomiasis were formed to be caused mainly by *Paramphistomum microbothrium*, and *P. cervi*.

Infections with the stomach flukes are common in some areas of Africa and Malek (1990) found that about 90% of the cattle slaughtered in the region of the White Nile reservoir were infected with these flukes.

Heavy infections are present to the extent that several thousands flukes may be recovered from the rumen of each animal.

1-2-3-2-3 Infections with Cestodes

Cysticercus bovis was first reported in cattle in 1934 (Eisa, et al1979). The overall infection rate with *Cysticercus bovis* in southern Sudan amounted to about 12%. Of this 21.5% were generalized infections.. The infections of cysticercosis varied with the different localities. It was highest in Kapoeta (39.71%) and Torit (20.7%).

The high percentage of infections in cattle lead to the assumption that the infection rate with the adult tapeworm (*Taenia saginata*) among the human population was also very high. Examination of 925 human stools, in Pibor district, from prisoners, school boys or natives were examined for the presence of *T. saginata* ova and 770 (83%) were found positive (Eisa, 1963).

Eisa (1966) stated that investigations carried in Upper Nile Province in 1964 indicated that this infections caused high economic losses in cattle to the extent that the Morley cattle with about 76% incidence, did not find any market to accept them. El-Khawad et al., (1976) reported that the incidence of *C. bovis* in cattle was 9% in Equatoria and 18% in Upper Nile. Similarly, in western Sudan it reached 23%. In Khartoum province, Gotbi and Suliman (1975) showed an infection rate of 10% in cattle slaughtered at Omdurman Central Abattoir.

Hydatid cyst was first reported in Khartoum in 1955 (Eisa, et al, 1979). In 1963 Eisa reported an incidence of 3.5% in cattle in Malakal. (Eisa, 1962) showed that the overall infection rate with hydatidosis in Equatoria and Upper Nile Provinces of southern Sudan was 25% in cattle, 19.4% in sheep and 33.3% in goats. The study was extended to include dogs which showed that 52.6% of the dog population in the two provinces harboured the adult tapeworm *Echinococcus granulosus*. A survery conducted by El-Khawad et al., (1979) to determine the incidence

of hydatidosis in meat animals slaughtered at Omdurman, Rufaa and Sennar abattoirs revealed that the highest incidence was found in camels (35.3%) followed by sheep (8.1 %), cattle (4.3%) and goats (3.2%). They showed that there was no sex difference. The localization of cysts in cattle, goats and camels was mainly in the lungs, but in sheep the predilection site seemed to be the liver. Similar observations were reported by Saad and Magzoub (1989) who showed that the incidence in camels and cattle was 48.69% and 3.84% respectively. Saad and Magzoub (1988) fed dogs with cysts obtained from cattle and camels. They found that the average period for the worm to develop to the mature stage was similar (43-45 days) in both cases, this was regarded as evidence for the suitability of cattle as intermediate hosts for *Echinococcus granulosus*. This was found to be in contrast with the observations of Macpherson *et al* (1985), who could not establish infection in experimental dogs fed with cysts of cattle origin in Kenya. The efficiency of indirect haemagglutination (IHA) and immunoelectrophoresis (IEP) in the diagnosis of hydatidosis was investigated by Saad and Hassan, (1989). They demonstrated that both IHA and IEP showed very low detection rates of antibodies in animal sera.

1-2-4 Factors affecting internal parasite infections in dairy cattle

The immune status of the individual animal

In a given herd, on the same pasture, egg counts can vary widely from animal to animal. Stress decreases immunity, so a sick or debilitated animal would be more susceptible to parasite infection and will typically have a higher parasite burden than healthy, less stressed cattle in the herd. Healthy adult cattle generally have a well developed immunity, resulting in lower worm burdens than in young animals with typically less

developed immunity. (Reinermeyer, 1990; Gibbs, 1979) There is also variability in infection rates among apparently healthy animals of the same age. To obtain a more accurate measurement of herd infection status, fecal sampling should include individuals in all the various age groups in the herd. The total number tested should account for 10-15% of the herd population. A broader sampling such as this will reduce the effects of individual variability, thus leading to a more precise herd analysis.

Internal parasites

The variable egg-laying capacity of different species of worms with similar egg types, maturity of the worm populations, and life cycle variations of the different species, for instance, the three main types of stomach worms in cattle, *Haemonchus contortus*, *Ostertagia ostertagi*, and *Trichostrongylus* species (hairworms), all produce very similar "strongyle-type" eggs.

Hatching these eggs (fecal culture) and identifying the larvae is the only method for absolute determination of which species are present. In the continental U.S., *Ostertagia ostertagi*, is considered to be the most damaging worm of cattle, (Craig *et al*, 1995; Baker, 1986) but the adult worm produces fewer eggs than either of the other two species that produce similar eggs.

Egg production can vary depending upon the developmental phase of the different worm populations present, and the age of the sexually mature worms. Different worm species can have dramatically different maturation rates, altering the prepatent period. Younger populations of mature nematodes typically produce more eggs per female. Fertility of the female nematodes decreases as population ages, leading to fewer eggs produced per adult female.

Prepatent period

Prepatent period, for parasites, refers to the period of time elapsed from when the infective larvae enter the host until the adult female begins to lay eggs, or produce larvae. The prepatent period can vary greatly among species of parasites. Looking at all of the species of cattle intestinal nematodes, prepatent period can vary from two weeks to over five months. The prepatent period can also vary greatly within a single species of worm for example, *Ostertagia ostertagi*, due to variations in its life cycle. In this worm larvae mature for part of their developmental phase in the glands of the stomach (abomasum) in cattle. With type 1 ostertagiasis, the time spent in the glands is brief, resulting in mature worm development in 17-21 days. The brown stomach worm can also go dormant or inhibited (pre-type 2 ostertagiasis) within these glands for extended periods. As many as 90% of *Ostertagia* larvae undergo arrested development and emerge at the appropriate time.(Baker, 1986; Craig, 1979; Williams *et al.*, 1983). The inhibited stage of pre-type 2 ostertagiasis can last for over five months.

The damaging parasitic disease, type 2 ostertagiasis, occurs before any significant increase in fecal egg production. Interestingly, it is not the egg-laying adult brown stomach worms that cause the most severe problems in cattle. Type 2 ostertagiasis occurs when dormant larvae emerge in large numbers from the glands of the stomach damaging the stomach wall, resulting in blood loss, impaired stomach function, and profuse watery diarrhea. These larvae will develop into egg producing adults about 5 days later.

Pasture

Contamination of the pasture with infective larvae can vary dramatically due to grass cover and moisture conditions. Lush pastures

create an environment that will allow infective larvae to survive and be more easily eaten with the forage,(Nansen *et al*, 1988), leading to increased infection rates and after the prepatent period, higher fecal egg counts.

Conversely, sparse dry pastures will reduce larvae available for infection, but won't necessarily affect survival of larvae on the pasture. Larvae have been found to go underground down to six inches and survive for over a year before emerging (Saqr *et al*, 1982). Therefore, low fecal egg counts don't necessarily mean that a pasture has a low parasite burden.

Weather

Weather conditions can affect larval availability,(Reinemeyer, 1990; Craig *et al*, 1995; Craig, 1979; Reinemeyer, 1994) thus indirectly affecting fecal examination results. Dry hot weather decreases the availability of infective larvae, similar to sparse pasture conditions. In general, with all internal parasites, moist temperate weather increases survivability of infective larvae in the vegetation and induces eggs to hatch. A warm steady rain will change the pasture environment almost immediately, making infective larvae more available on the grass for grazing cattle to ingest. Under conditions such as these, increased fecal egg counts can be expected two to three weeks later.

Season

Many parasites exhibit dramatic seasonal variation in egg production. As mentioned previously, the life cycle of (*Ostertagia ostertagi*) can vary dramatically. The inhibited phase of type 2 ostertagiasis typically occurs during the winter in the northern U.S., and during the hot dry summers in the southern U.S.(Craig, *et al*, 1995; Reinemeyer, 1994). During these periods of inhibition, adult worm

numbers decrease, resulting in dramatically reduced egg numbers. Considering this seasonal variation, fecal exams performed in mid-winter in Iowa would be of little value in determining the actual infection rate of the brown stomach worm in that herd. Early summer would be a better time to perform fecal evaluations to determine the presence of *Ostertagia ostertagi* with Iowa's climatic conditions. Coastal North Carolina has hot dry summers, and mild, moist winters. In this weather pattern the opposite inhibition pattern occurs, resulting in inhibition of the brown stomach worm during the summer. This demonstrates how brown stomach worm fecal egg counts can vary dramatically due to the location and the season.

Parasite Control Products

Fecal egg counts can be affected by the types of parasite control products and the timing of their use. When considering a particular antiparasitic product, the mechanism of action, duration of activity, and timing of administration will all affect the level of parasite control achieved, (Reinemeyer, 1990; Reinemeyer, 1994; Mckenna, 1989; Whittier, 1995) thus affecting fecal egg counts. Most parasite control compounds have an extremely limited residual activity, allowing immediate reinfection. (Gottschall, 1990; Mckellar, 1990). A newer class of compounds that controls both internal and external parasites has been demonstrated to be long acting against gastrointestinal nematodes (Mckenna, 1998; Armour, 1985).

All of the factors previously listed can have an impact on the effectiveness of antiparasitic treatment. Therefore, the timing of fecal sampling becomes a critical factor. Samples should be taken both at or just prior to the time of treatment and 14-21 days after treatment in order to obtain the most accurate information on treatment effectiveness.

Testing Methods

The results of fecal testing can vary depending on the test performed and the individual performing the test. Several different techniques are routinely used to perform fecal examinations. It is important that the same test and technique be used when comparing results of sequential tests. The test performed should also be quantitative, to determine the number of eggs per equal unit volume of faeces examined. Two tests that allow quantitative analysis are the Modified Wisconsin Double Centrifugation procedure and the McMaster technique. In addition, it is critical that the person performing the test has expertise in both performing the chosen procedure and identifying the eggs or larvae of different worm species.

1-2-5 Effects of internal parasites on dairy cattle

1-2-5-1 Clinical effects

These are the effects which are evident by physical and visual examination such as roughness of coat, anaemia, oedema and diarrhoea. (Gibbs, 1992).

1-2-5-2 Subclinical effects

These are the effects which interfere with production and reproduction and they are not evident by physical and visual examination such as reduced weight gain, decreased milk production, impaired reproduction and depressed immune responses and yet they can be economically important (Gibbs, 1992).

1-2-6 The economic importance of subclinical internal parasitism in dairy cows

Immunological resistance to disease in livestock may incur a production cost due to redirection of nutrients away from production tissues (Colditz, 2001).

(Spence *et al* 1992) investigated the milk production responses to internal parasites control in dairy cattle. They revealed that a significant increase in milk production, averaging 164 liter per cow per lactation [a 48% increase] was seen after cows infected with gastrointestinal nematodes, paramphistomes and *F. hepatica* were treated with broad-spectrum anthelmintics.

The same investigators (1996) also determined the effect of treating naturally acquired gastrointestinal nematode and paramphistomes infections on milk production in dairy cattle. This study revealed that milk production increased when the infected cows were treated with oxfendazole alone or oxfendazole and oxydozanide

A field study done to investigate the efficacy of levamisole on milk production of dairy cows revealed that injection of infected cows with levamisole at calving improved milk production. (Block *et al*, 1987).

Thus, Bliss and Todd (1976) demonstrated the economic advantages of anthelmintic treatment of adult dairy cattle at the time of parturition and again in mid lactation. Field trials demonstrated increased milk production (more than 200kg/lactation) after treatment of dairy cows passing fewer than 10 epg of faeces. Milk production was suppressed in cows given 200,000 trichostrongylid larvae when the larvae were administered in the first 90 days of lactation.

1-2-7 Control of internal parasitic diseases

The eradication of most helminth infections is not practical and

generally, such a course is not required in order to control economically important helminth diseases of livestock. Rather, the aim of control is to ensure that parasite population do not exceed levels compatible with economic production. This objective is achieved by three interrelated approaches: by grazing management, the use of anthelmintics, and the utilization of natural or artificial induced immunity. Potentially, the most efficient control requires the complete integration of all three facets. This is possible only on the basis of a full understanding of the epidemiology of infections.

Alternate grazing is a term usually given to the practice of sequentially stocking pasture with different species. As with mixed grazing, the major aim is to reduce residual pasture infestation to low levels and to limit further contamination harmful to the alternate host. In a 5- year study in Norway, Helle (1971) examined the effect of an annual alternation of sheep and cattle on sheep parasites. In the case of species that normally over winter on pasture, e.g *Ostertagia species* and *Nematodirus* species, the alternation reduced the pasture availability of these species to negligible levels.

However, this procedure had no effect on population of species which not normally survive the winter, e.g *H. contortus*, *Trichostrongylus* species, and *Cooperia curticei*.

In two trials in Australia, Southcott and Barger (1975) and Burger (1976) have assessed the decontamination of sheep and cattle pasture by varying cattle periods of grazing by the alternate host. Grazing sheep pasture with yearling cattle for 6,12 or 24 weeks resulted in reductions in numbers of *H. contortus* and *T. colubiformis* in test lambs. In comparison with continuous grazing by sheep, numbers of *Nematodirus* species, were only reduced after 24 weeks by cattle. Cattle pastures grazed by sheep for 6 weeks showed no reduction in number of *Ostertagia ostertagi* or *C.*

oncophora in test calves. After 12 weeks with sheep numbers of *Ostertagia ostertagi* though not of *Ostertagia oncophora* were reduced and after 24 weeks of alternate grazing both of these species were reduced. These trials provide evidence that the alternation of cattle and sheep could be an effective method of preparing parasitologically safer pastures.

The grazing of older, non-breeding, resistant stock along with young susceptible animals has long been advocated on the basis of a mainly theoretical assumption of a beneficial reduction in the infective larvae on pasture (Taylor, 1961). In Germany Burger (1976) surveyed trichostrongyle infections in Autumn on a considerable number of pasture grazed exclusively by cows or by calves. He found significantly higher numbers of larvae of the genera *Ostertagia*, *Cooperia*, and *Nematodirus* on calves pastures than on cows pasture. On the basis of this finding, Burger (1976) suggested that in the absence of available clean pasture, improved control of trichostrongyle infection during the late summer and autumn might be achieved by the transfer of calves to cows pastures at that time.

An alternative to a change to safe pasture is the use of "critical" strategic anthelmintic treatments which achieve the same effect by suppressing contamination at times when free-living development is minimal. This ensures that immediate re-infection is low and that the greatest proportion of the worm population is exposed to the anthelmintic (Southcott *et al.*, 1975). In this way, critical treatments can be used to enhance or reinforce natural discontinuities in pasture infestation from climatic factors.

Anderson (1973), had shown that two such treatments used in conjunction with the seasonal decontamination of pastures resulting from the dry summer period in Victoria, Australia, will produce safe grazing

for autumn and winter. In many farming situations, particularly in specialized intensive rearing systems, manipulations of grazing management is frequently limited, and the control of parasites must depend solely on the use of anthelmintics.

There are many factors which limit the use of anthelmintics practice. Gibson (1980) stated that these may be features connected with the host, such as the oesophageal groove reflex, development of immunity and epidemiological considerations in the use of anthelmintics. Other attributes of the drug itself may influence the way in which it acts. These include particle size, toxicity, range of activity and efficacy of small daily doses. Characters of worms which affect drug action include development of resistance and arrested development.

Chapter Two

Materials and methods

2-1 Study Area

The study was conducted in El-Rodwan Dairy Project which was located at the north western periphery of Omdurman Town .Omdurman town radiates from a focus on latitude 15° 38'N and longitude 32° 26'E to a radius of 7 to 10 km in all directions. Its mean minimum and maximum daily temperatures for the period of the study, which included three different seasons were as follows:

During the dry cool weather in December to February, the minimum and maximum daily temperatures were 13.7°C to 32.4°C respectively.

During summer, as from March to July , the weather was dry hot and the mean minimum and maximum daily temperatures were 25.4°C to 43°C respectively.

During the rainy season from August to October, the weather was wet hot and the mean minimum and maximum daily temperatures were 25.2°C to 41.7°C respectively.

Transitional weather occurs in November and July with fluctuating temperatures and humidity .

The mean relative humidity was 21%, 26% and 40% for the three seasons respectively.

The rainfall season reached its maximum during the period from mid July to mid September, during this period there was increase in the relative humidity. Minimum and maximum daily temperatures and the relative humidity during the period from January to September were obtained from the Metrological Department, Ministry of Aviation (2005) (Table 2.1).

Table (2-1): Monthly mean temperature, relative humidity and total rain fall during the period January to September, 2005

Month	Mean Temperature(°C)		Relative Humidity (%)	Total Rain Fall (mm)
	Maximum	Minimum		
January	31.9	13.2	27	0.0
February	33.0	13.8	25	0.0
March	37.1	16.7	15	0.0
April	41.1	21.1	16	Trace*
May	44.2	25.1	21	24.0
June	41.1	25.1	31	8.3
July	41.7	25.7	37	12.0
August	39.9	24.1	45	138.2
September	40.4	25.2	35	30.0

* Rain fall < 0.1 mm

2-2 Sampling procedure

El-Rodwan dairy project was selected because it is regarded as one of the most important sites of the semi -intensive systems for milk production in Khartoum State. Selection of pens was done according to cluster sampling method as described by Thrusfield (1995). Selection of clusters (10 pens) was done randomly and within each pen only 10% of the herd was sampled randomly. Information was collected by interviewing of owners and record data .Primary data was by samples collection and examination .

2-3 Dairy cattle housing and management in El-Rodwan dairy project

The construction of El-Rodwan dairy project was in the form of 50 pens within which 5000 head of dairy cattle were housed. The mean total number of animals in each pen was 100 head composed of young calves, heifers, dry herd, milking herd, pregnant cows and stud bulls. The constructions of these 50 pens were poorly designed fences made of mud. The space allowance per cow was very limited. The shade, which was not easy to be cleaned and which protected animals from wind and dusts, was built at the center of the pen with local materials such as metals and wood so it provided only partial shade. Animals were found crowded under this shade (Plate 2.2). The daily removal of dung from pens was done regularly in some pens and neglected in others. In El-Rodwan dairy project most of the animals were cross breeds with a limited number of local breeds but no pure foreign breeds. There was a continuous addition of animals from some parts of Sudan such as Gizera and White Nile areas to compensate for the culled ones.

2-3-1 Identification of animals

Identification of herd individuals in each pen was done by application of ear tags which corresponded with each cow page in the record book.

2-3-2 Records

In each pen there was a record book, containing information about each individual animal. The information included in the record book were: cow's name, cow's number, production record (milk yield, drying off date, lactation length), and reproduction record (service date, pregnancy status, calving date).

2-3-3 Feeding system

Feeding of animals consisted of two portions:

i) Green fodder

This consisted of pioneer (*Abu Sab'een*) grass and Rhodas grass.

ii) Concentrates:

This composed of wheat bran, molasses, chick manure, trace elements and salt.

Green fodder and concentrates were brought to animals in their pens directly from the market (plate 2.2 and 2.3).

2-3-4 Drinking system

The source of the water was wells. And the animals drink water adlibitum from troughs inside each pen (Plate 2.4).

2-3-5 Milking

Cows were milked manually twice a day in the morning at 04:00 am and in the early evening at 16:00 pm.

2-3-6 Health

Routine vaccination of animals against diseases such as contagious bovine pleuropneumonia and anthrax were not carried out because the owners believed that vaccination causes diseases and reduces the milk yield. Broad-spectrum anthelmintics such as Albendazoles were weekly given in drinking water.

2-3-7 Culling

Cows were culled for several reasons, the most important ones were: wasting diseases, old ages, udder problems, infertility problems and low milk yield.

2-3-8 Calves housing and management

In El-Rodwan dairy project, when calves were newly born, they were often in areas inside the pen with older calves and other cattle (Plate 2.5). Bedding which makes up the important part of calf environment for calf comfort, floor fall and ventilation, was absent. Calves are allowed to be with their dams for 3-7 days after birth to consume all milk, then with dams all night for 15 days. Later calves were separated and kept in collective penning for all ages and only left to suckle after milking.



Plate (2-1). General view of the dairy cattle housing at Al-Rodwan dairy project



Plate (2-2). General view of the green fodder at Al -Rodwan dairy project



Plate (2-3). General view of the concentrates at Al-Rodwan dairy project



Plate (2-4). General view of the drinking water troughs at Al-Rodwan dairy project



Plate (2-5). General view of the calves housing at Al-Rodwan dairy project

2-4 Study population

The animals that were sampled were dairy cattle in El-Rodwan dairy project during the three different seasons of the year. The cross breeds composed 89% (n = 89) of the sample while the local breeds were 11% (n = 11). The same percentage was recorded for sex, females being 81% (n = 81), and males 19% (n = 19). The age of the cattle was grouped into three groups namely, < 1, 1-3, and > 3 giving a percentage of 33%, 4%, and 63% respectively (table 2-3). Milk yield of wet cows was recorded from record books. The loss in the total number of animals under study during the last two seasons was due to culling.

2.5 Collection of samples

Two hundred and ninety faecal samples were collected during the three different seasons of the year from the same animals identified (100 faecal samples collected during the dry cool season in February to March 2005), (95 faecal samples collected during the dry hot season in May to June 2005) , and (95 faecal samples collected during the wet hot season in August to September 2005). They were collected manually straight from the rectum of the animal or from the ground only if the animal was seen passing out the faeces (Table 2- 2). These faecal samples were placed in plastic bags, labeled and immediately brought to the laboratory for examination.

Table (2-2): The total number of animals examined during the three different seasons of the year :

Seasons	Month	No. of animals examined
Dry cool	February – March	100
Dry hot	May – June	95
Wet hot	August – September	95
Total		290

Table (2-3) :Breed, sex, age groups, and milk yield of the animals included in the study :

Unit	Season Frequency (%)		
	Dry cool	Dry hot	Wet hot
Total No. of animals examined	100	95	95
<u>Breed:</u>			
Local	11(11)	11(11.58)	10(10.53)
Cross	89(89)	84(88.42)	88(89.47)
<u>Sex:</u>			
Male	19(19)	14(14.74)	14(14.74)
Female	81(81)	81(85.26)	81(85.26)
<u>Age (years):</u>			
< 1	33(33)	28(29.47)	28(29.47)
1-3	4(4)	4(4.21)	4(4.21)
> 3	63(63)	63(66.32)	63(66.32)
<u>Milk yield (Kg):</u>			
< 4	5(5)	5(5.26)	5(5.26)
4-8	39(39)	39(41.05)	39(41.05)
>8	22(22)	22(23.16)	22(23.16)

2-6 Faecal examination

The following techniques were adopted;

2-6-1 Flotation test

This method was used for detecting the eggs of nematodes, cestodes and protozoa. e.g. *Haemonchus species*, *Ascaris species*, *Strongyloides species*, *Trichuris species* and *Coccidia species*. The general laboratory technique was followed.

Two to three grams of faeces were taken in a mortar and emulsified with 42ml salt solution. They were ground with pestle and mixed well. The suspension was then poured through a tea sieve into a beaker to remove the large particles. The sieved suspension was then poured in a test tube. More of salt solution was added into the test tube until it was completely filled and then covered with a cover slip. The cover slip was removed after 20 minutes, placed onto a clean slide, and then examined under the microscope.

2-6-2 Sedimentation test

This method was used for detecting heavy eggs which do not float well in available flotation solutions. Those are the operculate eggs such as eggs of *fasciola*, paramphistomes and schistosomes. Two to Three grams of faeces were taken in a mortar and emulsified with 42 ml tap water. They were ground with pestle and mixed well. The suspension was then poured through a tea sieve into a beaker to remove the large particles. The sieved suspension was then poured in a centrifuge tubes and centrifuged initially at 1500 rpm for two minutes. The dirty supernatant was poured off and re-suspended in water and centrifuged at 1500 rpm for two minutes. This was repeated four times till the supernatant fluid was clear.

A bit of the deposit was then taken and smeared on a slide, covered and examined under the microscope.

2-7 Packed Cell Volume (King, 1976)

Two to three ml of blood sample was collected from the jugular vein of the same animals identified. The blood was collected using vacutainer with EDTA, labeled and immediately taken to the laboratory for the PCV determination. A capillary tube was taken, the end of the capillary tube was put on a drop of blood sample, filled to about three quarter, and sealed by plastoseal at one end. It was then put in the haematocrit centrifuge which was run for ten minutes. Then the tube was taken and put into the haematocrit reader to read the result.

2-8 Data analysis

Microsoft Excel (Windows 2003) and STATA 6.0 for Windows 98/95/NT were used for data analysis. Chi-Square (χ^2) was used for assessing the statistical association of various factors with the presence of internal parasites. Logistic regression model was employed to obtain the Odds Ratio (OR) which was only for those factors that gave statistical significant by using Chi-Square (χ^2).

Chapter Three

RESULTS

The results of examination of 290 faecal samples from dairy cattle at El-Rodwan dairy project using flotation and sedimentation tests showed that:

The presence of internal parasites was 16% (n = 100) during the dry cool season, 8.42% (n = 95%) during the dry hot season and 7.36% (n = 95) during the wet hot season, table (3-1).

Table (3-1) : Prevalence of internal parasites during the three different seasons of the year

Unit	Season Frequency (%)		
	Dry cool	Dry hot	Wet hot
Total No. of animals examined	100	95	95
<u>Packed Cell Volume (PCV)</u>			
Normal	32(32)	36(73-89)	32(33-68)
Abnormal	68(68)	59(62-11)	63(66-32)
<u>Faecal Examination</u>			
Positive	16(16)	8(8.42)	7(7.37)
Negative	84(84)	87(91.98)	88(92.63)

Prevalence of *Coccidia species* infection was observed during the three different seasons of the year given high prevalence 13% (n = 100)

during the dry cool season, 4.21% (n = 95) during the dry hot season, and 2.10% (n = 95) during the wet hot season.

Prevalence of *Fasciola species* infection was 1% (n = 100) during the dry cool season, 4.21% (n = 95) during the dry hot season and 4.21% (n = 95) during the wet hot season.

Prevalence of *Paramphistomum species* infection was 2% (n = 100) during the dry cool season, 0.0% (n = 95) during the dry hot season and 1.05% (n = 95) during the wet hot season, table (3.2).

Table (3-2) : Genera of internal parasites detected during the study period

Season	No. of animals examined	Prevalence (%)			Over all prevalence (%)
		<i>Coccidia species</i>	<i>Fasciola species</i>	<i>Paramphistomum species</i>	
Dry cool	100	13	1	2	16
Dry hot	95	4.21	4.21	0.0	8.42
Wet hot	95	2.10	4.21	1.05	7.36

The results showed that there was no effect of the season on the presence of internal parasites ($\chi^2 = 4.564$, $P > 0.05$) (Figure 3.1)

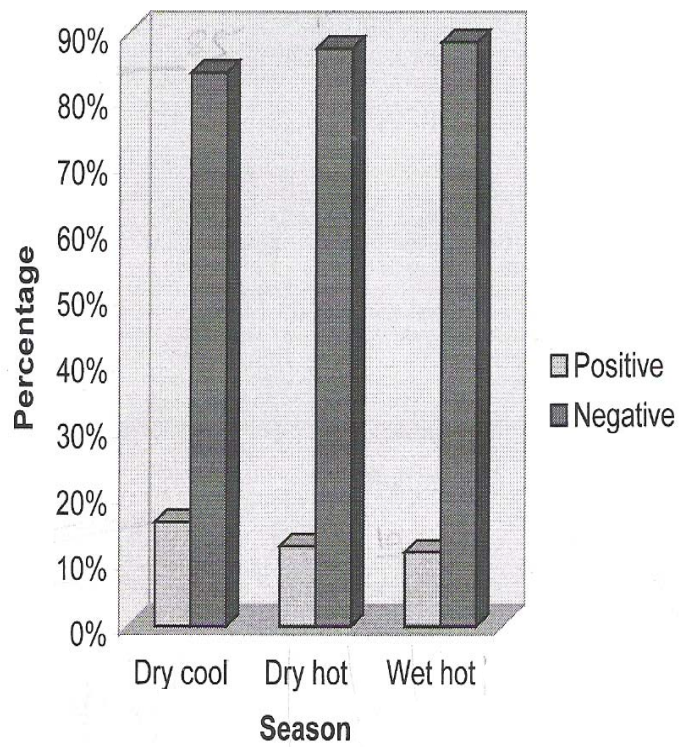


Figure (3.1) : The relationship between the season and the presence of internal parasites

The results showed that there was a positive correlation (t-test = 42.91, $P < 0.01$) between the milk yield and the presence of internal parasites, (Table 3.3).

Table (3-3): The relationship between milk yield and presence of internal parasites during the three different seasons of the year.

Factor	No. of animal examined			Mean		t-test		P-value
	Positive	Negative	Total	Positive	Negative	Positive	Negative	
Milk yield (Kg)	30	172	202	7.73	8.12	42.1	9	0.000**

** High significance ($P < 0.01$).

The results showed that there was no correlation between the PCV and the presence of internal parasites ($\chi^2 = 4.5084$, $P < 0.05$) (Figure 3.2 and table 3.4).

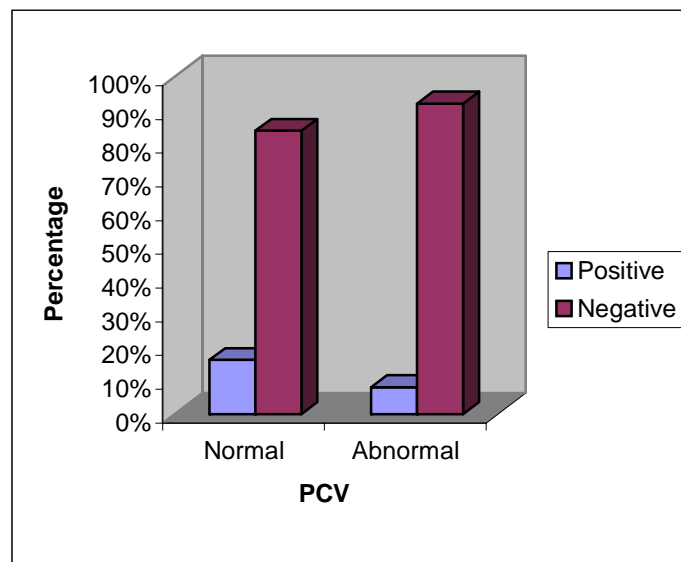


Figure (3-2) : The relationship between the Packed Cell Volume and the presence of internal parasites during the study period.

There was a positive correlation between the sex of animal and the presence of internal parasites and it could be a risk factor ($\chi^2 = 4.307$, $P < 0.05$, OR=6.479) (Table 3.4 and table 3-5).

There was a positive correlation between the breed of the animal and the presence of internal parasites ($\chi^2 = 7.716$, $P < 0.05$), however the odds ratio indicated that the breed could not be a risk factor for the presence of internal parasites (OR = 0.294) (Tables 3.4 and 3.5).

There was a positive correlation between the age of animal and the presence of internal parasites ($\chi^2 = 12.889$, $P < 0.05$) and the result was confirmed by the Odds Ratio which indicated that the age could be a risk factor for the presence of internal parasites (OR = 3.638) (Tables 3.4 and 3-5).

Table (3-4): The relationship between sex, breed, age, and the presence of internal parasites during the three different seasons of the year

Factor	Chi-square (χ^2)	P-value
Sex	4.307	0.038*
Breed	7.716	0.005**
Age	12.889	0.002**
Packed Cell Volume (PCV)	4.5084	1.375

Table (3.5) The quantification of the relationship between sex, breed, age, and PCV of internal parasites during the three different seasons of the year.

Factor	Standard error	Odd Ratio (OR)	95% confidence of interval
Sex	6.670	6.479*	0.861-48.727
Breed	0.136	0.294	0.118-0.728
Age	1.626	3.638*	1.515-8.735

* = OR > 1 = a risk factor for presence of internal parasites.

Chapter Four

Discussion

The results of this study showed that infections with internal parasites were common during the three different seasons of the year in the selected dairy cattle in the study area. The prevalence was 16%, 8% and 7% during the dry cool, dry hot and the wet hot season respectively. In spite of the continuous use of anthelmintics preparations, many investigations on internal parasites in dairy cattle had been documented from different production systems in the Sudan. Saad (2004) revealed infections with Fascioliasis in White Nile and Gezira states. He also (2004) revealed that paramphistomiasis was common in White Nile and Gezira states. Abdel Malakal (1959) reported *Fasciola gigantica* from bile ducts of cattle in Waw, Rombek, Sennar, Kosti, Fashir and Nyala. Karib (1962) stated the prevalence of *F. gigantica* in the area along the White Nile which lay between Dueim and Malakal. El-Khawad *et al* (1976) reported the incidence of *F. gigantica* in Equatoria, Bahr El-Ghazal and the Upper Nile. Also they (1978) reported the infection in Baggara cattle in Western Sudan.. Another studies on cattle conducted by El-Doush (1995) reported the presence of *F. gigantica* in faecal samples collected from the slaughter house in Atbara. Malek (1990) stated that 90% of the cattle slaughtered in the region of the White Nile reservoir were infected with paramphistomiasis,

The presence of internal parasites in El-Rodwan dairy project was mostly due to the poor hygiene in the pens resulting from crowding of animals in the center of the pen where there was a partial shade and this made it difficult to achieve thorough removal of animal dung. Also animals were fed on fodder purchased from the market which increased the risk of infection with internal parasites as contamination with the

infective stages can happen at any point. Also there was a continuous addition of new animals particularly from areas known to be endemic for internal parasitic infections such as Gezira and White Nile areas.

Our study revealed that there was no positive correlation between the season and the occurrence of internal parasites. This result disagrees with a study conducted in Central Kenya by Waruiru *et al* (2000) who stated that the season had a significant influence on the prevalence and intensity of helminth and coccidial infections in dairy cattle and they indicated that the higher intensity of infection with helminth and *coccidia* was found in the wet season. Similarly, the same authors (2001) stated that the total worm burden in the animals were highest during the rainy season and lowest during the dry season. Another study done by Keyyu *et al.*, (2005) in the southern highlands of Tanzania revealed that the proportion of animals passing fluke eggs increased gradually from the early dry season and peaked at the end of the dry season and the early part of the rainy season. This disagreement was attributed to the type of animal husbandry and management of the dairy cattle as most of these studies, conducted to assess the effect of the season on the prevalence of internal parasites, had been done on pastoral production systems while our study was done in semi closed or semi intensive production system. In the semi closed system the microclimate is relatively stable throughout the year giving a chance for continuous development irrespective of the seasonal variation, knowing that the arid climate in our study area could be very harsh during hot season.

A positive association was obtained between the age of the animal and the presence of internal parasites. The odd ratio (OR = 3.638) indicated that age could be a risk factor. This result was confirmed by Duval (1997) who stated that the age as well as the weight of animal determines susceptibility to infection with parasites. Young animals do

not have strong immunity to parasitic infection during the first year in pasture. He also revealed that adult animals are much less susceptible to most parasites, unless they are in poor living conditions. Furthermore, another study conducted in Central Kenya by Waruiru *et al* (2000) indicated that the age as well as the sex and season had a great effect on the prevalence of helminth and coccidial infections in dairy cattle. The study revealed that the age-specific intensity was in the following order: for strongyles, immature animals of 6-12 months of age had the highest egg counts, followed by young calves and adults. However, calves had significantly higher oocyst counts than immatures or adults. Liver fluke egg counts did not differ significantly between immatures and adult cattle, this result was also confirmed by longitudinal descriptive study done in the Southern Highlands of Tanzania by Keyyu *et al.*, (2005) who reported that adults and yearlings had the highest prevalence of flukes in all management systems throughout the year. Moreover, another study conducted on Eimeriosis in dairy cattle farms in Tanzania by Chibunda, *et al* (1997) stated that the oocyst output was high in calves, followed by weaners; adults had the lowest oocyst output. The study also revealed that no coccidial oocysts were detected in calves less than 12 days old. The same result was confirmed by another study conducted in South Africa on occurrence and diversity of bovine coccidiosis by Matjila and Penzhorn (2002) who indicated that adults had very low oocyst per gram of faeces whereas high oocyst per gram of faeces were only recorded in calves. Young animals are the most susceptible to infection with coccidiosis, and the reason this disease often develops early in life is that the young dairy calves are confined in previously contaminated areas, i.e., hutches, calf stalls, etc, or they are housed in overcrowded conditions. Once a facility has become contaminated, it has the potential for a recurring problem.

A positive correlation was seen between the sex of the animal and the presence of internal parasites and it could reach the level of the risk-factor (OR=6.479). This finding disagrees with a finding in a study conducted in Central Kenya by Waruiru *et al.*, (2000) who stated that the sex of the animal had no significant effect on the prevalence and intensity of helminth and coccidial infections in dairy cattle. Also another study done in Sudan by El-Doush (1995) indicated that there was no sex preferences regarding the presence of liver and gastrointestinal parasites in the dairy cattle in Atbara. This disagreement is due to the fact that females constituted the majority of the study population because the owners in Al-Rodwan dairy project mainly keep females for milk production purposes (81%) while the males are sold to be slaughtered and few of them are kept for reproduction purposes ,a fact that affected this finding.

A significant correlation was obtained for the breed of the animal and the presence of internal parasites. However, the breed could not reach the level of risk factor (OR=0.294). This result was confirmed by Magona and Mayende in Uganda (2002) who revealed that infections with *fasciola* and gastrointestinal nematodes were higher in the exotic breed compared to the local breeds. Furthermore, another study conducted by Duval (1997) revealed that an animal which had never been exposed to infections with worms can not develop resistance and immunity. Local breeds have strong ability to prevent the establishment or limit the subsequent development of parasitic infection due to the previous continuous exposure to worm infection. However, the limited number of local breeds included in this study could not be taken a definite reflection of breed susceptibility .Also the cross –bred animals have varying ratios of foreign blood.

As seen from the result, there was a highly significant association between the milk yield and the presence of internal parasites. This result was confirmed by Bliss *et al.*, (1976) who demonstrated increased milk production after treatment of dairy cows passing fewer than 10 epg of faeces. Also they demonstrated that milk production was suppressed in cows given 200.000 trichostrongylid larvae when the larvae were administered in the first 90 days of lactation. Furthermore, another study conducted in New South Wales by Spence *et al.*, (1992) indicated that a significant increase in milk production was seen after cows infected with gastrointestinal nematodes, paramphistomes and *Fasciola hepatica* were treated with broad-spectrum anthelmintics.

A negative correlation was observed between the PCV and the presence of internal parasites. This result was completely in contrast with Magona (2002) who reported high percentage of anaemia in exotic breed compared to the local breed due to infection with both blood and internal parasites during his investigation in farms in Uganda.

This disagreement may be due to the continuous administration of broad spectrum anthelmintics such as albendazole in drinking water, and this may be the reason why there were no nematode parasites encountered during this study.

Based on results of this study it could be concluded that infections with internal parasites were prevalent in the dairy cattle of Al Rodwan dairy project. The seasonal variations had no influence on the prevalence of internal parasites in a semi closed dairy production system if other factors such as good management and adequate nutrition were controlled. Reduced milk production level is the most important feature for infection with internal parasites.

It is hence recommended that good management, adequate nutrition, and regular deworming using anthelmintics such as albendazole

is necessary for the control of parasitic infections. More investigations should be done to assess the relationship between the seasonal variations and the presence of internal parasites under arid climatic conditions.

Awareness of the dairy farms owners concerning the economic importance of parasitic infections need to be raised.

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